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Methods for sexually transmitted disease prevention programs to estimate the health and medical cost impact of changes in their budget

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Abstract

Background—The purpose of this paper was to describe methods that sexually transmitted disease (STD) programs can use to estimate the potential effects of changes in their budgets in terms of disease burden and direct medical costs.

Methods—We proposed two distinct approaches to estimate the potential effect of changes in funding on subsequent STD burden, one based on an analysis of state-level STD prevention funding and gonorrhea case rates and one based on analyses of the effect of Disease Intervention Specialist (DIS) activities on gonorrhea case rates. We also illustrated how programs can estimate the impact of budget changes on intermediate outcomes, such as partner services. Finally, we provided an example of the application of these methods for a hypothetical state STD prevention program.

Results—The methods we proposed can provide general approximations of how a change in STD prevention funding might affect the level of STD prevention services provided, STD incidence rates, and the direct medical cost burden of STDs. In applying these methods to a hypothetical state, a reduction in annual funding of $200,000 was estimated to lead to subsequent increases in STDs of1.6% to 3.6%. Over 10 years, thereduction in funding totaled $2.0 million, whereas the cumulative, additional direct medical costs of the increase in STDs totaled $3.7 to $8.4 million.

Conclusions—The methods we proposed, though subject to important limitations, can allow STD prevention personnel to calculate evidence-based estimates of the effects of changes in their budget.

Introduction

Several published studies have provided evidence that the amount of resources allocated for the prevention of sexually transmitted diseases (STDs) does indeed have an effect on the

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incidence of STDs at the population level.[1-6] For example, an analysis of state-level gonorrhea case rates and federal funding for STD and HIV prevention from 1981 to 1998 indicated that higher levels of prevention spending in a given year were associated with lower reported rates of gonorrhea in subsequent years.[1]Because the estimated direct medical cost of STDs (including HIV) in the United States is almost $20 billion annually,[7] reductions in the incidence of STDs can yield substantial health and financial benefits.

Several published studies have provided evidence that the activities of Disease Intervention Specialists (DIS) can reduce the population-level burden of STDs.[4,8-12] DIS perform STD prevention activities such as partner notification, which involves interviewing people diagnosed with STDs, obtaining information about their sex partners, and locating these partners so that they can be referred for testing and treatment.[4,13,14] DIS have been described as the backbone of state and local STD prevention programs, and perform a range of other activities in addition to partner notification, including education and risk reduction counseling, and provider and community outreach and engagement.[13,14]

The purpose of this report was to describe methods for state and local STD prevention programs in the United States to estimate the potential impact of increases or decreases in their budget, in terms of changes in the incidence of STDs and in the direct medical costs of STDs.We also illustrated how programs can estimate intermediate outcomes of changes in their budget, such as in terms of changes in DIS services provided. Finally, we provided an example of the application of these methods for a hypothetical state STD prevention program.

Methods

Overview

We proposed two distinct approaches to estimate the potential impact of changes in STD prevention resources on STD incidence (Figure 1). The first approach (the historical formula approach) was based on the observed relationship between state-level gonorrhea case rates and state-level STD prevention funding over an 18-year period.[1] The second approach (the DIS approach) was based on the observed association between DIS activities and subsequent gonorrhea case rates at the population-level in several settings.[4] Either or both of these approaches could be used, depending on factors such as the needs of the user and the data available to the user.

In addition to estimating the change in STD incidence arising from a budget change, we also described how to estimate changes in (1) the direct medical costs of STDs and (2) the provision of STD services, such as STD patient interviews. Finally, to illustrate the application of our methods, we estimated the impact of a change in budget for a hypothetical, state-level STD program.Table 1 provides a summary of the parameter values we applied. A technical appendix provides additional details.

Estimating the effect of funding changes on STD burden, method 1 (historical formula approach)

This approach was based on an analysis of state-level gonorrhea case rates and federal funding for STD prevention from 1981 to 1998.[1] This analysis of historical data indicated that each additional dollar of prevention funding per capita (updated to 2016 dollars) in a given year was associated with subsequent reductions in the rate of reported cases of gonorrhea of 16%, after controlling for a range of factors associated with state-level gonorrhea rates.[1] To put this estimate in perspective, we note that allocations of federal funds distributed by the Centers for Disease Control and Prevention to states for STD prevention averaged \$0.29 per capita in 2015, with a range of \$0.17 to \$0.52.[15] We assumed this reduction of 16% could be applied not only for gonorrhea but also for syphilis and chlamydia.

If the change in prevention funding is ΔX, and the overall population in the jurisdiction of the STD program is P, the estimated change in the STI incidence rate (for gonorrhea, syphilis, and chlamydia) as a result of the change in funding can be estimated as $-0.16(\Delta X/P)$. For example, if there is a decrease in funding, ΔX will be negative and this expression will be positive, indicating STD incidence rates after the decrease in funding would be higher than if there had been no change in funding.

When there are changes in the delivery of STD prevention services, the resulting change in STD incidence can become more pronounced over time as a new equilibrium is reached.[16] To account for the phasing-in of changes in STD incidence over time following a change in prevention funding, we assumed that the change in STD incidence in year 2 would be $1 + \beta$ times that of year 1, that the change in year 3 would be $1 + \beta + \beta^2$ times that of year 1, that the change in year 4 would be $1 + \beta + \beta^2 + \beta^3$ times that of year 1, and so on, as described in more detail in the technical appendix. A value of 0.7 was applied for β (Table 1), based on the regression model used in the analysis of state-level gonorrhea rates and federal funding for STD prevention.[1]

Estimating the effect of funding changes on STD burden, method 2 (DIS approach)

This approach adapted a published estimate of the change in STD incidence rates that can be expected following a change in the provision of DIS services.[4] Specifically, an analysis of a decade of historical records of rates of reported gonorrhea cases and partner notification services in New York State (excluding New York City) indicated that each 10% increase in DIS activities (e.g., number of index patients interviewed, or number of partners provided epidemiologic treatment) could reduce gonorrhea case rates by 2% to 6%.[4] We applied the lower of these two estimates of impact (2%), because this 2% estimate is more conservative and is also consistent with results from ecological analyses conducted in the 1970's and 1980's, which suggested that the scaling up of DIS activities can reduce population-level gonorrhea incidence,[10-12] as described in the technical appendix. We assumed this 2% estimate could be applied not only for gonorrhea but also for syphilis and chlamydia.

For this exercise, we assumed the entire change in STD prevention resources would be applied to the DIS workforce, such that the number of DIS would be increased or decreased, depending on whether the budget is increased or decreased. We also assumed that the percentage change in DIS activities would be approximately equal to the percentage change in number of DIS employed by the STD program.

To calculate the change in the number of DIS that would result from a change in budget, programs can use their own data regarding the annual cost per DIS, or can apply a national estimate of $73,600. This national estimate reflects a salary of $45,677 (based on the federal general schedule level 9, step 3 salary as of January 2016[17]), multiplied by 1.61 to account for benefits,[18] and rounded to the nearest $100). When applying this national estimate, the change in DIS (ΔDIS) due to a change in funding of $X (ΔX) can be calculated as ΔDIS =ΔX/$73,600. For example, if there is an increase in funding, ΔX will be positive and ΔDIS will be positive, indicating an increase in DIS.

The percentage change in DIS activities (%DIS) can be approximated as %DIS =ΔDIS/N, where N is the number of DIS employed by the STD program before the change in budget. For consistency, in the event of a budget decrease, the decrease in DIS should not exceed 100%.Finally, the percentage change in STD incidence rates attributable to the change in budget can be estimated as -%DIS/5, where the division by 5 is applied because each 10% change in DIS activities is associated with a 2% change in STD incidence rates. The STD incidence rate that results from applying this percentage change can be interpreted as the new equilibrium, and can be phased in over time following the same relative trajectory as calculated above for the historical formula approach (see technical appendix).

Estimating the change in direct medical costs of STDs

The change in the direct medical costs due to the change in STD incidence was estimated as follows. First, the direct medical costs of syphilis, gonorrhea, and chlamydia were approximated by multiplying the change in the estimated number of infections of syphilis, gonorrhea, and chlamydia by $770, $230, and $210, respectively. These three values represent the average lifetime cost per new infection of syphilis, gonorrhea, and chlamydia, respectively.[7]

We also estimated the change in the number and cost of STD-attributable HIV infections. To do so, we assumed that the probability of an STD-attributable HIV infection per STD infection was 0.0105, 0.0005, and 0.0005 for syphilis, gonorrhea, and chlamydia, respectively.[19,20] A lifetime cost of $351,000 per HIV infection was applied.[21] All costs were updated to 2016 dollars, and future costs were discounted to present value at 3% annually.

Estimating the effect of funding changes on intermediate outcomes

Programs might also want to know the effect of budget changes on intermediate outcomes, such as DIS activities performed. We described methods to estimate the change in the number of index STD patient interviews conducted. Programs can apply similar methods to examine other intermediate outcomes of interest.

For this exercise, we assumed the change in the number of DIS can be calculated as ΔDIS =ΔX/$73,600, as described above. We then estimated the change in the number of index

STD patient interviews conducted each year due to the change in the number of DIS. The key piece of information needed for this estimation was the number of index patient interviews that the average DIS performs in a year. Programs without data on the number of index patient interviews conducted per year can approximate this value based on their number of reported STD cases, multiplied by published estimates of the average percentage of these cases that are interviewed (Table 1). Alternatively, programs can apply a literature-based estimate that each DIS can perform about 400 index patient interviews per year.[22-24] Using the estimate of 400, the change in the number of STD patient interviews per year can be expressed as 400ΔDIS.

Description of hypothetical state used for illustration of results

To illustrate the methods described above, we calculated the impact of a reduction in STD prevention funding of $200,000 in a hypothetical state of 6.5 million people. This hypothetical state was constructed to have an approximately average share (one 50th) of the nation’s population and reported number of STD cases. For example, the number of reported cases for 2015 in this state was assumed to be 1,000 for syphilis, 8,000 for gonorrhea, and 30,500 for chlamydia, calculated as the national number of reported cases in 2015[25]divided by 50 and rounded to the nearest 500. The state was assumed to have 15DIS before the reduction in budget.

Results

The results below describe the estimated impact of the $200,000 budget cut for the hypothetical state.

Estimating the effect of funding changes on STD burden, method 1 (historical formula approach)

The relative change in STDs was calculated as -0.16(ΔX/P), or -0.16(-200,000/6,500,000), or 0.49%. That is, in the first year of the budget cut, STD incidence rates were estimated to be 0.49% higher than they would have been in the absence of the budget cut. When assuming that the budget cut becomes permanent and would lead to a new equilibrium STD incidence rate at year 10, the percentage increase in STD incidence (relative to a scenario of no budget cut) was 0.84% in year 2, 1.37% in year 5, 1.57% in year 9, and 1.59% in year 10 (Table 2A).

Estimating the effect of funding changes on STD burden, method 2 (DIS approach)

The percentage change in DIS was calculated as (ΔX/$73,600)/N, or –(200,000/73,600)/15, or -18.1%. The relative change in STDs was calculated as -(-18.1%)/5, or 3.62%. That is, STD incidence was estimated to be 3.62% higher than it would have been in the absence of a budget cut.When we assumed this 3.62% increase would correspond to the new equilibrium STD incidence rate in year 10 after the funding cut, the percentage increase in STD incidence due to the budget cut was 1.12% in year 1, 1.90% in year 2, 3.10% in year 5, and 3.58% in year 9 (Table 2B).

Estimating the change in direct medical costs of STDs

In both approaches, the total funding reduction would amount to $2 million over the 10 years, or about $1.76 million when discounted to year 1. Changes in the costs of STDs were calculated using the cost per infection estimates in Table 1.

Based on the historical formula approach, in the 10 years after the budget cut there would be an estimated cumulative 146 additional syphilis infections, 2,106 additional gonorrhea infections, 7,250 additional chlamydia infections, and 6.2 additional STD-attributable HIV infections, with additional direct medical costs totaling $3.7 million (Table 2A).

Based on the DIS approach, in the 10 years after the budget cut there would be an estimated cumulative 332 additional syphilis infections, 4,786 additional gonorrhea infections, 16,473 additional chlamydia infections, and 14.1 additional STD-attributable HIV infections, with additional direct medical costs totaling $8.4 million (Table 2B).

Estimating the effect of funding changes on provision of services

The $200,000 budget cut for this state resulted in an estimated loss of 2.72DIS, ($\Delta DIS = -200{,}000/73{,}600$), and an estimated reduction of 1,087 in the number of STD index cases interviewed, calculated as -2.72*400.

Discussion

In this paper, we described methods that STD programs can use to estimate the potential effects of changes in their STD prevention budgets. Although there is no way to predict with any certainty and precision the impact of changes in the amount of funding allocated for STD prevention, the methods we proposed can provide general approximations of how a change in STD prevention funding might affect the level of STD prevention services provided (in terms of DIS activities), STD incidence rates, and the direct medical cost burden of STDs. We have developed a spreadsheet-based tool, available from the corresponding author upon reasonable request, to facilitate the application of these methods.

Although STD prevention programs can avert considerable medical costs, these cost savings rarely accrue to the STD programs. Instead, the beneficiaries of the averted costs are usually the payers of health care services, such as health insurance companies and government-funded health insurance programs such as Medicaid.[2,26,27] Programs with data on how the medical costs of STIs and HIV are apportioned across various payers could conduct additional analyses from a range of different perspectives, such as that of the “state” vs “other” payers.

Many factors affect the population-level burden of STDs, including but not limited to sexual and health-seeking behaviors, sexual network and mixing characteristics, and social determinants of health, such as poverty, racism, income inequality, and access to quality health care.[28-31] Most of these factors are beyond the control of STD programs. The study on which our historical formula approach is based attempted to control for these factors, and our approach assumes these factors are constant over time. Thus, the predicted effects of changes in the STD prevention budget should be interpreted as compared to an “all else equal" scenario of no budget change. For example, suppose our approach were used to estimate that STD incidence rates will be 5% lower as a result of an increase in the STD prevention budget. This result should not be interpreted to mean that STD rates will necessarily decrease by 5%, but rather STD rates will be an estimated 5% lower than what they would have been without the increase in budget.

There are three main strengths to the methods we propose. First, the data requirements needed to generate these estimates are minimal, and programs can apply national-level data in place of local data if necessary. Second, we proposed two distinct methods to estimate the impact of changes in STD prevention funding on STD incidence rates. Both methods yielded results that showed an increase in direct medical costs that exceeded the budget reductions (the estimates ranged from 210% to 478% of the cumulative budget reductions over the 10-year period). Third, both of these methods are data-based, making use of published studies that examined the impact of STD prevention activities at the population level over long time frames.[1,4]

The limitations of our approach are numerous and substantial. At best, these methods provide rough approximations of the potential impact of changes in STD prevention funding. The actual impact of changes in prevention funding could be notably different from these approximations. Both approaches use linear approximations and do not account for decreasing or increasing returns to scale, and thus are better suited for assessing relatively small changes in funding, such as 5%, than relatively large changes such as 50%. The projections generated by both approaches do not account for population growth, and changes in the population at risk for STIs would affect the expected number of STIs. The change in the number of DIS was approximated by dividing the change in budget by the average cost (salary plus benefits) per DIS; this approximation ignored other DIS-related costs such as transportation (mileage) costs and personnel costs for the support and supervision of DIS.[32]

For simplicity, we proposed that changes in STD program services could be described by focusing entirely on changes in DIS activities. The programmatic changes in response to budget changes might be more varied. STD programs at both the state and local level employ different staffing models, intervention and service mixes, and may have varying abilities to cut particular expenditures in response to budget cuts. A survey conducted in late 2013 – early 2014 found that local health departments employed a variety of strategies to accommodate budget reductions in fiscal years 2011-2012, including closing STD clinics, reducing hours at STD clinics, increasing fees and copays, and reducing partner services.[33] However, 42% of surveyed local health departments experiencing budget cuts reduced partner services, suggesting that DIS activities are frequently curtailed when budgets are decreased.[33]

The studies on which we based our assumptions of program impact used gonorrhea case rates as the primary outcome measures; our application of these studies assumed similar proportional effects on syphilis and chlamydia. Further, these source studies used gonorrhea data from the 1990's and early 2000's, and might not reflect the current epidemiology of gonorrhea or the potential effects of current STD prevention programs. Finally, our direct medical cost estimates are subject to uncertainty, particularly in the probability and cost of

STD-attributable HIV infections. The technical appendix describes approaches to address the uncertainty in the key parameter values, and the spreadsheet-based tool we have developed can be used to generate a range of predicted outcomes in addition to the base-case point estimates.

STD prevention program directors and other personnel are at times asked to provide information about the impact of their programs and to provide estimates of the effects of potential changes in the amount of funding allocated to their program. The methods we proposed, though subject to important limitations, can allow STD prevention personnel to calculate evidence-based responses to such inquiries.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

1. Chesson HW, Harrison P, Scotton CR, Varghese B. Does funding for HIV and sexually transmitted disease prevention matter? Evidence from panel data. Eval Rev. 2005; 29(1):3–23. [PubMed: 15604117]
2. Chaulk CP, Zenilman J. Sexually transmitted disease control in the era of managed care: "magic bullet" or "shadow on the land"? J Public Health Manag Pract. 1997; 3(2):61–70.
3. Chesson H, Owusu-Edusei K Jr. Examining the impact of federally-funded syphilis elimination activities in the USA. Soc Sci Med. 2008; 67(12):2059–2062. [PubMed: 18952341]
4. Du P, Coles FB, Gerber T, McNutt LA. Effects of partner notification on reducing gonorrhea incidence rate. Sex Transm Dis. 2007; 34(4):189–194. [PubMed: 16980919]
5. Brown ST, Wiesner PJ. Problems and approaches to the control and surveillance of sexually transmitted agents associated with pelvic inflammatory disease in the United States. Am J Obstet Gynecol. 1980; 138(7 Pt 2):1096–1100. [PubMed: 6894061]
6. Gallet CA. The impact of public health spending on California STD rates. Int Adv Econ Res. 2017; 23(2):149–159.
7. Owusu-Edusei K Jr, Chesson HW, Gift TL, et al. The estimated direct medical cost of selected sexually transmitted infections in the United States, 2008. Sex Transm Dis. 2013; 40(3):197–201. [PubMed: 23403600]
8. Han Y, Coles FB, Muse A, Hipp S. Assessment of a geographically targeted field intervention on gonorrhea incidence in two New York State counties. Sex Transm Dis. 1999; 26(5):296–302. [PubMed: 10333285]
9. Talbot MD, Kinghorn GR. Epidemiology and control of gonorrhoea in Sheffield. Genitourin Med. 1985; 61(4):230–233. [PubMed: 3926631]
10. Woodhouse DE, Potterat JJ, Muth JB, Pratts CI, Rothenberg RB, Fogle JS 2nd. A civilian-military partnership to reduce the incidence of gonorrhea. Public Health Rep. 1985; 100(1):61–65. [PubMed: 3918326]
11. Phillips L, Potterat JJ, Rothenberg RB, Pratts C, King RD. Focused interviewing in gonorrhea control. Am J Public Health. 1980; 70(7):705–708. [PubMed: 7386704]
12. Wigfield AS. 27 years of uninterrupted contact tracing. The 'Tyneside Scheme'. Br J Vener Dis. 1972; 48(1):37–50. [PubMed: 5067063]
13. Mermin, JH., Bolan, G. [June 23, 2017] Strengthening public health at its core: a focus on Disease Intervention Specialists. National Association of County and City Health Officials (NACCHO). 2015. http://www.phaboard.org/wp-content/uploads/nacchoexchange_winter2015_vol14iss1_infectiousdisease-7.pdf
14. National Coalition of STD Directors. [June 23 2017] National DIS Recognition Day. http://www.ncsddc.org/DIS

15. Bolan, G. DSTDP webinar for AAPPS grantees. Atlanta: Division of STD Prevention (DSTDP), Centers for Disease Control and Prevention; 2017.
16. White PJ, Ward H, Cassell JA, Mercer CH, Garnett GP. Vicious and virtuous circles in the dynamics of infectious disease and the provision of health care: gonorrhea in Britain as an example. J Infect Dis. 2005; 192(5):824–836. [PubMed: 16088832]
17. US Office of Personnel Management. [May 8, 2017] Salary table 2016-GS incorporating the 1% general schedule increase effective January 2016. 2016. https://www.opm.gov/policy-data-oversight/pay-leave/salaries-wages/salary-tables/pdf/2016/GS.pdf
18. Bureau of Labor Statistics. [May 8, 2017] Employer costs per hour worked for employee compensation and costs as a percent of total compensation: state and local government workers, by occupational and industry group, December 2016. 2017. https://www.bls.gov/news.release/ecec.t04.htm
19. Chesson HW, Collins D, Koski K. Formulas for estimating the costs averted by sexually transmitted infection (STI) prevention programs in the United States. Cost Eff Resour Alloc. 2008; 6:10. [PubMed: 18500996]
20. Chesson HW, Pinkerton SD. Sexually transmitted diseases and the increased risk for HIV transmission: implications for cost-effectiveness analyses of sexually transmitted disease prevention interventions. J Acquir Immune Defic Syndr. 2000; 24(1):48–56. [PubMed: 10877495]
21. Farnham PG, Holtgrave DR, Gopalappa C, Hutchinson AB, Sansom SL. Lifetime costs and quality-adjusted life years saved from HIV prevention in the test and treat era. J Acquir Immune Defic Syndr. 2013; 64(2):e15–e18. [PubMed: 24047975]
22. Heumann CL, Katz DA, Dombrowski JC, Bennett AB, Manhart LE, Golden MR. Comparison of in-person versus telephone interviews for early syphilis and human immunodeficiency virus partner services in King County, Washington (2010-2014). Sex Transm Dis. 2017; 44(4):249–254. [PubMed: 28282653]
23. Gunn RA, Harper SL. Emphasizing infectious syphilis partner notification. Sex Transm Dis. 1998; 25(4):218–219. [PubMed: 9564726]
24. Macke BA, Hennessy MH, McFarlane M. Predictors of time spent on partner notification in four US sites. Sex Transm Infect. 2000; 76(5):371–374. [PubMed: 11141854]
25. Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance, 2015. Atlanta: U.S. Department of Health and Human Services; 2016.
26. Gift TL, Kissinger P, Mohammed H, Leichliter JS, Hogben M, Golden MR. The cost and cost-effectiveness of expedited partner therapy compared with standard partner referral for the treatment of chlamydia or gonorrhea. Sex Transm Dis. 2011; 38(11):1067–1073. [PubMed: 21992986]
27. Frost JJ, Sonfield A, Zolna MR, Finer LB. Return on investment: a fuller assessment of the benefits and cost savings of the US publicly funded family planning program. Milbank Q. 2014; 92(4): 696–749. [PubMed: 25314928]
28. Newman LM, Berman SM. Epidemiology of STD disparities in African American communities. Sex TransmDis. 2008; 35(12 Suppl):S4–12.
29. Hogben M, Leichliter JS. Social determinants and sexually transmitted disease disparities. Sex Transm Dis. 2008; 35(12 Suppl):S13–S18. [PubMed: 18936725]
30. Adimora AA, Schoenbach VJ, Martinson FE, Donaldson KH, Fullilove RE, Aral SO. Social context of sexual relationships among rural African Americans. Sex Transm Dis. 2001; 28(2):69–76. [PubMed: 11234788]
31. Nakashima AK, Rolfs RT, Flock ML, Kilmarx P, Greenspan JR. Epidemiology of syphilis in the United States, 1941--1993. Sex TransmDis. 1996; 23(1):16–23.
32. Peterman TA, Toomey KE, Dicker LW, Zaidi AA, Wroten JE, Carolina J. Partner notification for syphilis: a randomized, controlled trial of three approaches. Sex Transm Dis. 1997; 24(9):511–518. [PubMed: 9339968]
33. Leichliter JS, Heyer K, Peterman TA, et al. US public sexually transmitted disease clinical services in an era of declining public health funding: 2013-2014. Sex Transm Dis. 2017; 44(8):505–509. [PubMed: 28703733]

34. Satterwhite CL, Torrone E, Meites E, et al. Sexually transmitted infections smong US women and men: prevalence and incidence estimates, 2008. Sex Transm Dis. 2013; 40(3):187–193. [PubMed: 23403598]

35. Golden MR, Hogben M, Handsfield HH, St Lawrence JS, Potterat JJ, Holmes KK. Partner notification for HIV and STD in the United States: low coverage for gonorrhea, chlamydial infection, and HIV. Sex Transm Dis. 2003; 30(6):490–496. [PubMed: 12782949]

36. Macke BA, Hennessy M, McFarlane MM, Bliss MJ. Partner notification in the real world: a four site time-allocation study. Sex Transm Dis. 1998; 25(10):561–568. [PubMed: 9858354]

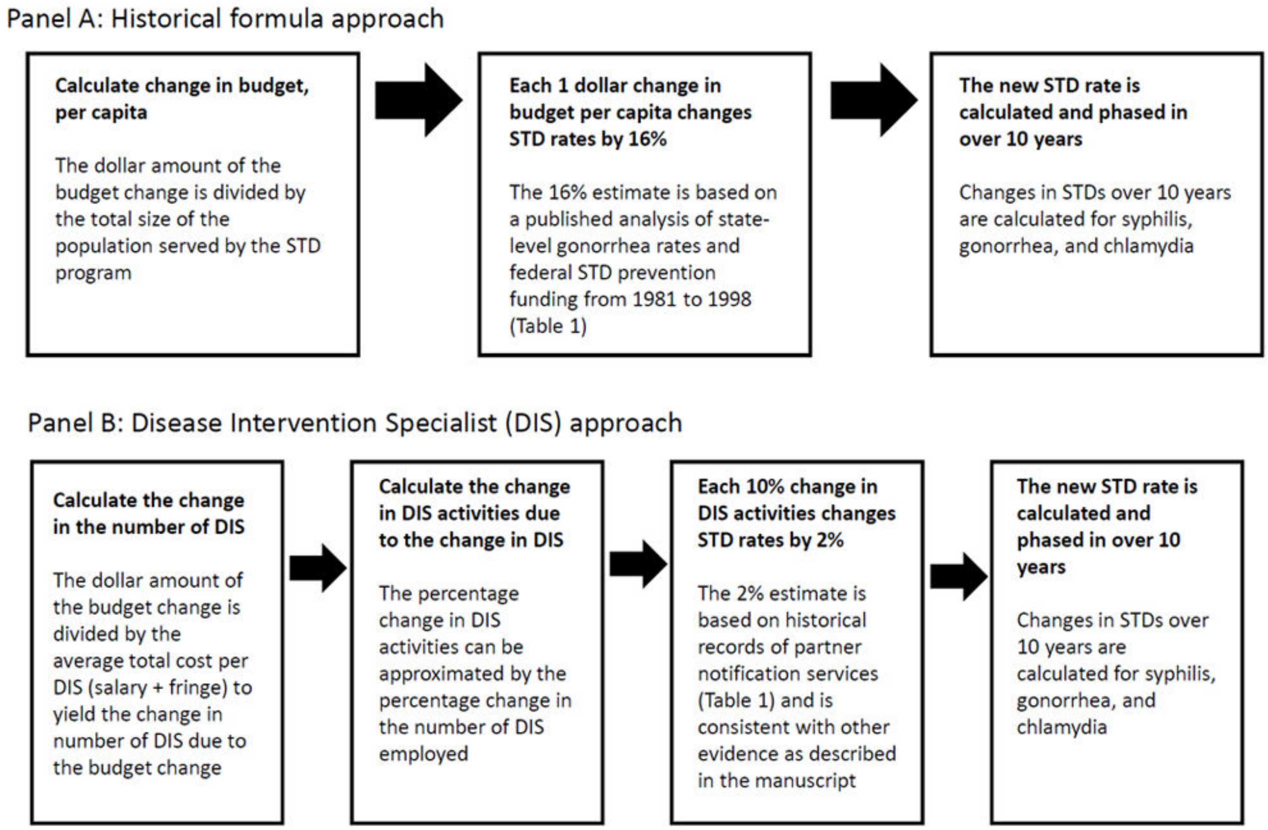

Figure 1.

Schematic of two approaches to estimate the effect of changes in STD prevention budget on subsequent STD incidence rates

Table 1

Parameters used to estimate the effects of a change in the amount of funding for STD prevention

Parameter	Value
Parameters used to estimate the impact of a budget changes on STD incidence	
Percent change in STDs per $1 per capita change in STD prevention funding	16%[1]
Percent change in STDs per 10 percent change in Disease Intervention Specialist (DIS) activities	2%[4]
Annual cost (salary + benefits) of one Disease Intervention Specialist (DIS)	$73,600[17,18]
β parameter used to phase in the estimated changes in STD incidence (see text)	0.70[1]
Parameters used to quantify the burden of STDs before the budget change	
Number of reported primary, secondary, and early latent syphilis cases in 2015, nationally	48,045
Number of reported gonorrhea cases in 2015, nationally	395,216
Number of reported chlamydia cases in 2015, nationally	1,526,658
Estimated annual incidence of syphilis, nationally	55,400[34]
Estimated annual incidence of gonorrhea, nationally	820,000[34]
Estimated annual incidence of chlamydia, nationally	2,860,000[34]
Parameters used to estimate changes in direct medical costs of STDs	
Average lifetime cost per syphilis infection	$770[7]
Average lifetime cost per gonorrhea infection	$230[7]
Average lifetime cost per chlamydia infection	$210[7]
Average lifetime cost per HIV infection (both sexes)	$351,000[21]
Probability of STD-attributable HIV infection, per syphilis infection	0.0105[19,20]
Probability of STD-attributable HIV infection, per gonorrhea infection	0.0005[19,20]
Probability of STD-attributable HIV infection, per chlamydia infection	0.0005[19,20]
Parameters used to estimate intermediate effects of changes in budget	
Percentage of syphilis cases interviewed	89%[35]
Percentage of gonorrhea cases interviewed	17%[35]
Percentage of chlamydia cases interviewed	12%[35]
Annual number of index patient interviews performed by one DIS	400[22,24,36]

Medical costs were updated to 2016 US dollars using the health care component of the personal consumption expenditures index. These probabilities of an STD-attributable HIV infection are lower than in the original publication,[20] and reflect adjustments to account for factors such as partner overlap and HIV serosorting.[19]

See the technical appendix for more details.

Table 2

Results: Estimated number and cost of additional infections after 10% STD prevention budget cut in hypothetical state

Panel A: Results from the "Historical formula" approach

Year	Percentage increase in STIs due to budget cut	Additional number of syphilis infections	Additional number of gonorrhea infections	Additional number of chlamydia infections	Additional number of STD-attributable HIV infections	Total additional costs, discounted to Year 1
Year 1	0.49%	6	82	281	0.2	$167,000
Year 2	0.84%	10	139	478	0.4	$275,000
Year 3	1.08%	12	179	616	0.5	$344,000
Year 4	1.25%	14	207	713	0.6	$387,000
Year 5	1.37%	16	227	780	0.7	$411,000
Year 6	1.45%	17	240	827	0.7	$423,000
Year 7	1.51%	17	250	860	0.7	$427,000
Year 8	1.55%	18	257	884	0.8	$426,000
Year 9	1.57%	18	261	900	0.8	$421,000
Year 10	1.59%	18	265	911	0.8	$414,000
Total		146	2,106	7,250	6.2	$3,697,000
Panel B: Results from the "Disease Intervention Specialist (DIS)" approach						
Year 1	1.12%	13	186	639	0.5	$379,000
Year 2	1.90%	22	316	1,086	0.9	$626,000
Year 3	2.45%	28	407	1,400	1.2	$783,000
Year 4	2.83%	33	470	1,619	1.4	$879,000
Year 5	3.10%	36	515	1,772	1.5	$934,000
Year 6	3.29%	38	546	1,880	1.6	$962,000
Year 7	3.42%	39	568	1,955	1.7	$971,000
Year 8	3.51%	41	583	2,008	1.7	$968,000
Year 9	3.58%	41	594	2,044	1.8	$957,000
Year 10	3.62%	42	601	2,070	1.8	$941,000
Total		332	4,786	16,473	14.1	$8,401,000

The bottom row is the only row with cumulative results. The first 10 rows of results (Year 1 through Year 10) show the impact of the change in funding for the given year compared to the year before the change in funding (Year 0). The column "Percentage increase in STIs due to budget cut" compares STD incidence in the given year (1 through 10) after the budget change to STD incidence that would have occurred in the absence of the budget change in this hypothetical state. In the example in Panel B, STD incidence rates in the first year after the budget change (year 1) would be 1.12% higher than they would have been in the absence of the budget change.Before the change in budget, the number of new infections annually (reported plus unreported) was estimated at 1,153 for syphilis, 16,599 for gonorrhea, and 57,138 chlamydia, calculated by assuming the state's share of the nation's estimated incident infections (Table 1) was equal to the state's share of the nation's reported number of cases.